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09/937160

JC03 Rec'd PCT/PTO 20 SEP 2001

Coat d h ld r and r d in a rod-typ w b coating apparatus

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FIELD OF THE INVENTION

~~The~~ present invention relates to a rod doctor according to the preamble of ~~claim 1~~.

BACKGROUND OF THE INVENTION

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In coating a web of paper or board, the coating mix is first applied to the surface of a moving web, whereupon the excess coating is removed from the surface of the web and the coating layer is smoothed. Finally, the excess moisture content of the coating is removed in dryers. In blade application, a doctor blade is used for metering the applied amount of coat and smoothing the surface of the applied coating. Also a rod doctor, an air doctor or different kinds of rolls or scrapers can be used in the metering of the coating mix.

In most cases, the doctor blade of a blade coater can be replaced by a doctor rod. The rod doctor comprises a framework, which extends over the cross-machine width of the paper/boardmaking machine and has connected thereto a flexible loading hose, and a cradle into which the doctor rod is rotatingly mounted. The rod is rotated in the cradle by means of a drive mechanism generally in a reverse direction to the travel direction of the moving web. Typically, the cradle is fabricated from a polymeric material, but may also be made from metal materials, for instance. Also the doctor rod may be made from a polymeric or metal material.

A problem generally occurring in conventional rod doctor constructions is vibration of the rod that makes the

applied coat layer uneven after leveling. Such vibration also causes clearly detectable pulsation in the running of the rod drive motors. A plausible cause of the vibration is the high friction between the cradle and the rod rotating therein. The amplitude of the vibration has also been found to increase as the paper/boardmaking machines become wider. To reduce the friction, the gap between the cradle and the rod can be filled with water that acts as a lubricant. However, the lubricating water may leak from the cradle into the coating mix thus diluting the coating and deteriorating the quality of the applied coat.

Another problem typically handicapping rod doctor assemblies is a rapid wear of the rod and its support cradle that also causes unevenness on the applied coat. Cradles made from urethane polymers have been found particularly prone to a fast wear. Attempts have been made to slow down the wear rate by means different ways, e.g., by coating the rod with a chromium, a glass/carbon-fiber or ceramic surface coatings, but these measures only serve to improve the wear resistance of the rod without exhibiting any essential reduction of the friction between the rod and the cradle.

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SUMMARY OF THE INVENTION

It is an object of the present invention to overcome the drawbacks of the above-described prior art techniques and to provide an entirely novel type of rod doctor.

The goal of the invention is achieved by way of surfacing at least the cradle of the rod doctor by a thin surface coating layer. When necessary, a surface coating may also

be made on the rod that supportedly rotates in the cradle. The surface coating used herein is selected from a group of hard materials having good sliding and self-lubricating properties, whereby the coefficient of friction between the cradle and the rod rotating therein is reduced. By the same token, the vibration of the doctor is reduced and the wear of the rotating rod and its cradle is lessened. The coating layer may be fabricated using, e.g., so-called vacuum deposition techniques, one of which is physical vapor deposition.

~~More specifically, the leveling rod according to the invention is characterized by what is stated in the characterizing part of claim 1.~~

The invention offers significant benefits.

By virtue of the approach according to the invention, the sliding conditions between the rod and the cradle are improved, whereby the rod vibration and the problems associated therewith are reduced or even eliminated entirely. Due to the improved sliding properties, the drive mechanisms of a lower power rating than those of the prior art may be used for rotating the rod. The wear rate of the rod and its cradle is reduced resulting in less frequent need for leveling rod unit maintenance and giving a longer life. The rod can be rotated in its cradle without necessarily needing any lubricating water, whereby the web coating problems caused by water leakage are eliminated. Simultaneously, also the construction of the leveling rod unit is simplified, because no connec-tions or other specific means for the lubrication water

circulation are required. The surface coating also serves to improve the corrosion resistance of the cradle and the rod.

In the following, the invention will be examined in greater detail by making reference to the appended drawings in which

Figure 1 shows a first embodiment of a rod doctor according to the invention having its cradle surfaced; and

Figure 2 shows another embodiment of a rod doctor according to the invention having both the cradle and the rod surfaced.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

The leveling rod unit shown in figure 1 comprises support frame elements 2, 8 extending over the entire width of the paper/boardmaking machine and having a flexible loading hose 4 mounted therebetween. Into the support frame element 2 is adapted a cradle 3 having a rod 1 adapted to supportedly rotate therein. The rod 1 is rotated by means of a drive mechanism, typically reverse to the travel direction of a web 5 being coated. The rod 1 is pressed by means of the loading hose 4 against the web 5 being coated, whereby the excess coating mix applied to the surface of the web 5 is removed and the applied coating layer is smoothed.

The cradle 3 is covered by a surfacing layer 6 with a thickness typically varying from a few nanometers to a few tens of micrometers. Advantageously, the layer 6 is

selected from the group of hard materials exhibiting good sliding and self-lubricating properties.

As shown in figure 2, both the leveling rod cradle 3 and the rod 1 rotatingly mounted therein are provided with a surfacing layer 6, 7. The surfacing layer 7 serves to improve the wear resistance of the rod 1 and to reduce the coefficient of friction between the cradle 3 and the rod 1. The surfacing layer 7 of the rod 1 may be of the same material as that of the surfacing layer 6 of the cradle 3. Normally, the surfacing layers 6, 7 are made from different materials, whereby the seizing tendency and wear rate of the sliding surfaces are generally reduced.

The surfacing layers 6, 7 may be formed by means of, e.g., vacuum deposition techniques. One such vacuum deposition method is the so-called physical vapor deposition (PVD), wherein the deposition process is carried out under a vacuum or in a low-pressure chamber into which the gas-phase coating material is introduced. Conventionally, the coating material is vaporized by means of an electron beam or resistive heating. Transported in the gas phase, the coating material adheres to the surface of the object being surfaced. When required, the coating process can be performed at an elevated temperature of about 400-500 °C.

bA4 A surfacing layer fabricated by vacuum deposition techniques is comparatively thin; its thickness typically varies from 1 nm to 90 m. In spite of its infinitesimal thickness, the surfacing layer is entirely free from

pores and conforms without cracks to the contour of the object being coated as the layer is produced at an atomic layer deposition level. The substrate to be surfaced by vacuum deposition can be of almost any material such as a metal, stone, plastic or glass. The surfacing materials used herein are selected from the groups of metals, metal alloys, oxides, nitrides or carbides. Different kinds of surface coatings may vary vastly in terms of their properties.

The surfacing layers 6, 7 of the cradle 3 and the rod 1 may be, e.g., a silicon molybdenum alloy in which silicon makes the surfacing layer 6, 7 hard, while molybdenum gives the favorable self-lubricating and sliding properties. Another advantageous alternative as a surface coating is a vacuum-deposited layer of diamond (DLC, Diamond Layer Coating) having a hardness typically in the range of 6,000 - 10,000 HV. This coating is highly resistant to acids and bases. Furthermore, a diamond coating gives a very low coefficient of friction against most other materials. For instance, the coefficient of friction between steel and a diamond coating is typically 0.1 in a sliding contact of dry surfaces that is only one-fifth of the coefficient of friction between two sliding steel surfaces under similar conditions. Other advantageous surfacing layer materials in an embodiment according to the invention are chromium and cromium-teflon composition.

In addition to those described above, the invention may have alternative embodiments.

The technique used for applying the surface coating may be selected rather freely. Instead of using vacuum deposition, the coating process may be performed using, e.g., thermal spraying in which the coating material is molten into a hot plasma that is directed to impinge on the surface of the object to be coated. In thermal spraying, the coating materials are generally metals and plastics such as chromium, molybdenum or teflon. As the number of suitable materials for the surfacing layers 6, 7 of the cradle 3 and the rod 1 is vast, the coating material must be selected according to the requirements set by the intended application and other similar factors. The rod doctor according to the invention may be used for metering the amount of coating mix applied to the applicator roll surface in a film-transfer coater and for leveling the applied coat.

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